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(54) Abstract Title
Process for coating and sublistatically printing articles

(57) The articles are moved continuously through a washer 14 for washing, a rinser 16 for rinsing, and thereafter through an open area for atmospheric drying. Movement of the dried articles continues to a spray booth 22, where the articles are spray-coated with a dye-receptive solution and thereafter through an oven 26 for drying and curing the coating material. The articles continue through a cooling cycle, then to an inspection station 28, where they are examined for consistency of coating thickness, and are thereafter sublistatically printed by utilizing a mechanical device for applying pressure for the purpose of holding a sublistatic transfer sheet against the article surface to be imprinted whereby dyeing is effected by the application of pressure and heat.

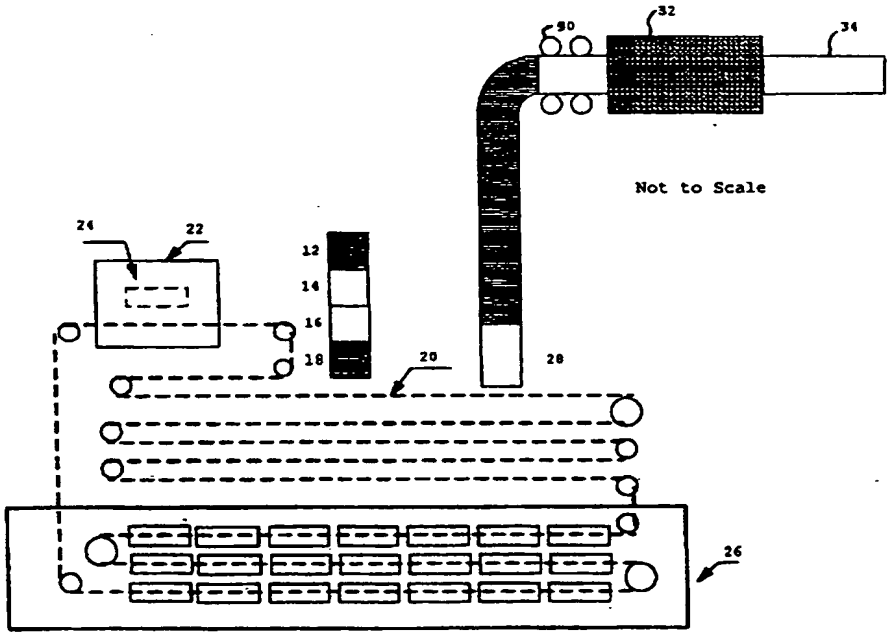

FIGURE 1

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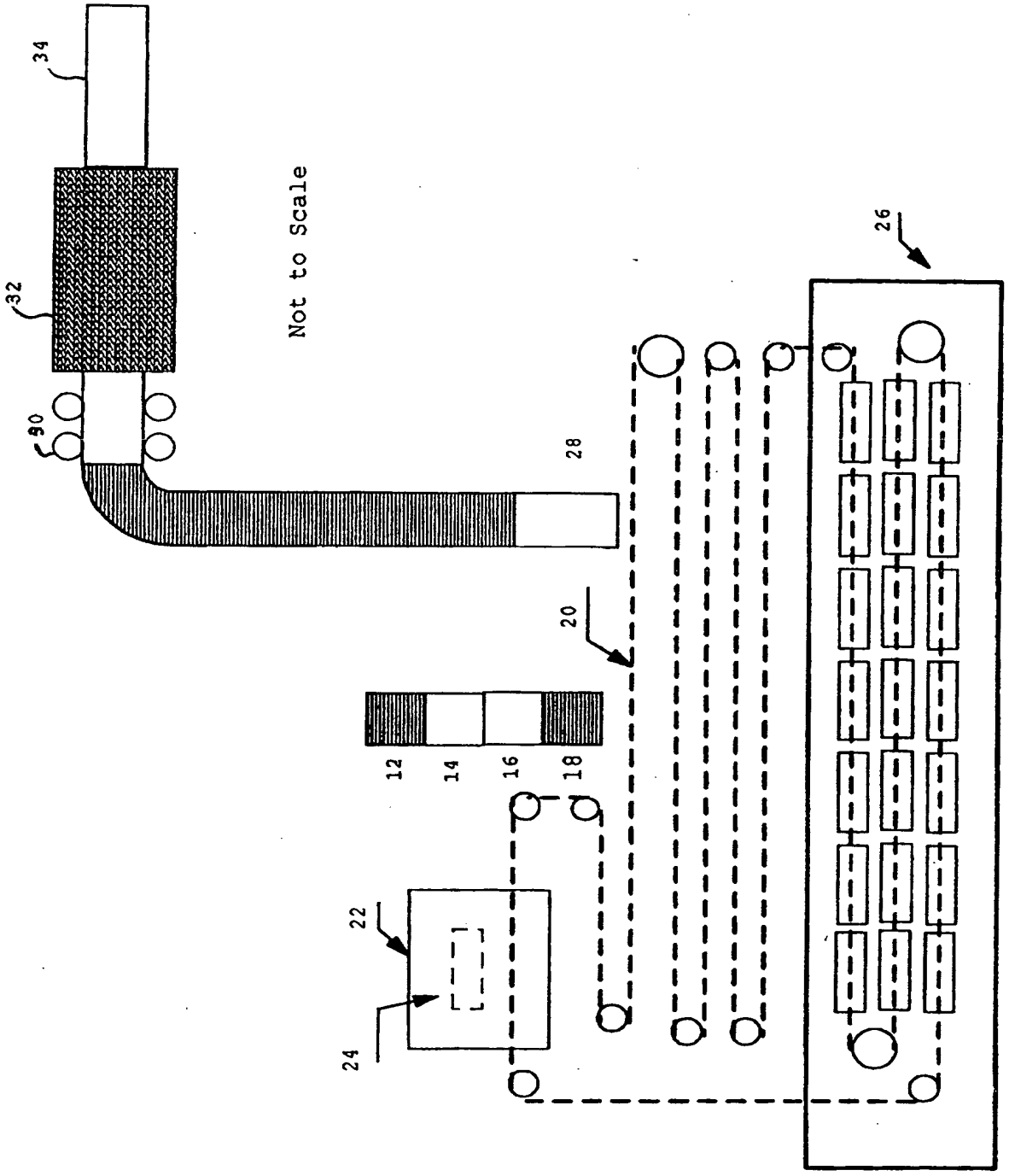

FIGURE 1

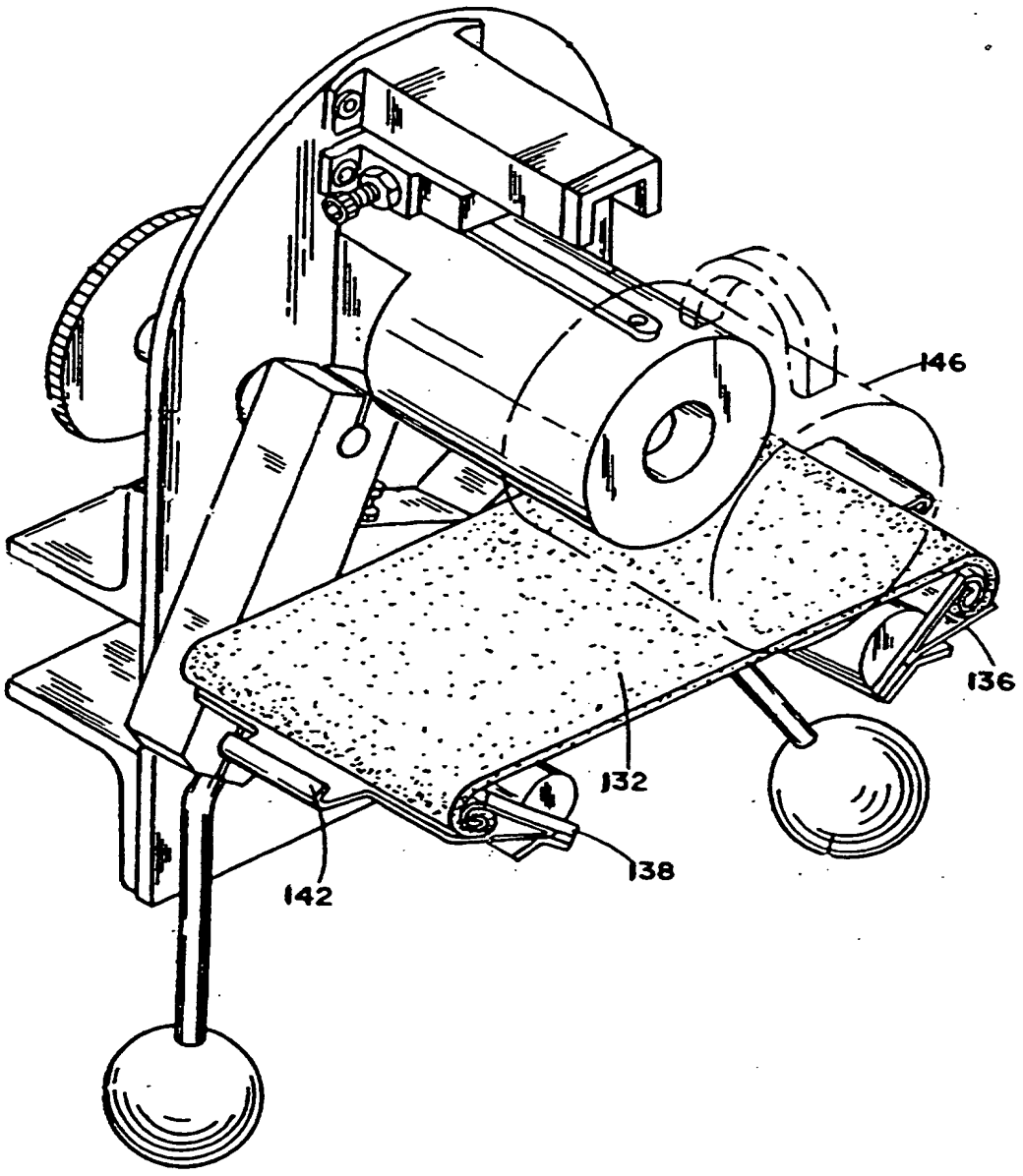

FIG. 2

PROCESS FOR COATING AND SUBLISTATICALLY PRINTING ARTICLES

The present invention relates generally to a process for preparing articles for surface printing and thereafter sublistatically printing on these article surfaces by positioning a sublistatic transfer sheet against the article surfaces.

There are a number of techniques presently being utilized to prepare ceramic and glass articles for surface printing. Additionally, there are numerous devices available for effecting sublistatic printing on ceramic and glass article surfaces. In all such devices, the processes are separate and distinct. Pretreated ceramic or glass articles are introduced to a sublistatic printing process for a subsequent operation. In all of these cases, the process is slow and rather inefficient, particularly in that there are actually two processes in use instead of a single assembly line for effecting both preparation of article surfaces and actual printing of the surfaces. Thus, there is a need to automate ceramic or glass article preparation and printing techniques to the extent possible in order to increase the output of the two operations to provide an adequate volume of such articles and to more effectively provide printed articles of various types.

SUMMARY OF THE INVENTION

The present invention provides a process for sublistatically printing upon or decorating articles, comprising the steps of applying a dye-receptive coating to the articles, inspecting the coated articles for quality and consistency of coating thickness and subjecting the acceptable coatings on the articles to sublistatic printing; the articles being in substantially continuous motion between the coating application, inspection and printing steps.

A preferred form of the process for coating and subsequently sublistatically printing ceramic or glass articles on the article surface includes the steps of: washing the articles in an appropriate washer, rinsing the articles, positioning the articles on selectively movable support devices such as conveyors, so they can be moved generally through an open area for

drying; applying to the articles a dye-receptive solution to form the coating thereon; moving the articles through an oven to cure the dye-receptive material; inspecting the dry coated articles for quality and consistency of coating thickness, and printing or otherwise decorating the surfaces of the ceramic articles by the use of a sublistatic transfer sheet held against the article surface by a mechanical device such as, for example, an elastic band.

The present invention thus provides a single process that combines the preparatory coating of articles with the surface printing or decoration of such articles by sublistatic printing. Use of the process can achieve a high quality dye-receptive coating, a consistency of coating thickness, and a sharper printed image than has heretofore been obtained.

There are additional preferred features of the invention that will be described hereinafter with reference to an illustrative embodiment shown in the drawings, and may also form the subject matter of the dependent claims appended hereto. In this respect, it is to be understood that the invention is not limited in its application to the details of the construction and to the arrangement of the components set forth below. The invention is capable of other embodiments and of being practiced and carried out in several ways. The phraseology and terminology employed herein are by way of explanatory example and are not to be regarded as limiting. Those skilled in the art will appreciate that the concept upon which this disclosure is based may readily be utilized as a basis for the design of other structures, methods, and systems for carrying out the several purposes of the invention. In that respect, the invention is to be regarded as including such equivalent methods as fall within the scope of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan and schematic of a floor plan of a facility utilizing the process of the present invention.

Figure 2 is a perspective view of an apparatus for effecting sublistatic printing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, a plurality of ceramic or glass articles are placed into trays or positioned onto a conveyor at a loading area 12 for movement through the continuous operation embodying the present inventive concept. For purposes of this description, the ceramic or glass articles will be mugs, such as those used for coffee or tea, which have become quite popular when printed for resorts as souvenirs or as corporate endorsements. While the process is equally applicable to other ceramic and glass articles such as decorative tiles and the like, or indeed applicable to any article whose surface is not inherently sublistatically printable, it will be more convenient to refer generally to mugs a representative of those articles for the balance of this description.

Mugs are loaded at loading area 12, onto trays, racks or directly onto a meshed belt and moved into a prewash/washer compartment 14 where a thorough cleaning of the mug surface is undertaken to remove any foreign substances associated therewith. From the washer, the mugs are moved to the rinse compartment 16, where they are exposed to fresh water. The clear rinse water may contain chemical drying agents which function to reduce the surface tension of the residual water on the mugs, thus facilitating more rapid drying in the open atmosphere. The drying agent per se is not part of the present invention, except as used in steps of the process and is available commercially from, for example, Ecolabs, Inc. It may be possible for uncoated mugs to arrive uncontaminated to the extent that wash/rinse is unnecessary. In most situations however, it is desirable to include the wash and rinse steps to maximize the amount of product of acceptable quality.

Just prior to being exposed to the drying action, (in this example atmospheric drying), the mugs are loaded onto support devices at loading station 18 which is designed to maximize the surface exposure of the mug, so that the exterior and other surfaces of the mug can be exposed to the drying action and to the other operations subsequently to be described.

The supported articles are then moved through an extended conveyor system shown generally as 20. Atmospheric drying of the mugs takes place as they are moved from the

loading station 18 to a coating booth 22. In booth 22 the mugs are sprayed with a dye-receptive solution to form a coating on all exposed surfaces. Since the conveyor is continuously in motion, the movement and activation of the spray guns that automatically apply coating material to the mugs as they pass through the coating booth is coordinated with the conveyor movement by a tracking unit 24 appropriately programmed.

From the spray booth, the mugs move on conveyor system 20 to enter a separately enclosed oven shown generally as 26, where they traverse the necessary conveyor lengths to achieve adequate drying and curing of the applied coating material. Additional conveyor lengths for such drying and curing as well as cooling are positioned downstream of the oven 26. Conventional ovens (convection or radiant) may be used for the curing operation and are quite effective for this purpose. However, it has been found that in most cases ovens utilizing infrared emitters provide the most expedient and consistent curing of the ceramic articles. In this description, infrared curing will be employed.

After the articles have been dried and cured in the oven, they are conveyed to an inspection station 28 where they are removed from extended conveyor 20. Here they are inspected (100% or statistically sampled) for consistency of coating thickness.

Mugs that are of acceptable quality are then conveyed to a wrapping station 30, where a sublistatic transfer sheet is applied and held against the article surface by a mechanical device. Sublistatic printing is most effectively done by utilizing equipment such as shown in fig. 2 and also disclosed in U.S. Patent No. 4,989,508 entitled Device for Facilitating Sublistatic Printing. This equipment facilitates sublistatic printing by positioning transfer sheets intimately against the surfaces of the articles to be imprinted and which includes a mechanical device, usually in the form of an elastic band 132, that envelopes or encircles the arcuate surfaces of an article 146 to be imprinted to hold the sublistatic transfer sheet (not shown) in place against the article surface and to exert a uniform perpendicular or radial pressure thereagainst. The elastic band 132 is of sufficient stretched length to encircle the article 146 and of sufficient diminished width when stretched to substantially cover the entire area to be printed. A gripping or holding element 136, 138 may be affixed to each end of the

band and may include fixtures 142 which connect to one another to secure the band after it encircles the article to be imprinted. Full details of the operation of the device are shown in U.S. Patent No. 4,989,508.

As more fully explained in for example U.S. Patent Nos. 4,246,331, 4,342,281 and 4,989,508, sublistatic printing involves first placing dye in the desired distribution and color on a vehicle or transfer sheet such as suitable paper. The dye may consist of particles in an appropriate carrier such as water, forming a viscous liquid which can be applied to the transfer sheet for example by conventional printing methods. Alternatively the dye may be a dry powder applied to the sheet electrostatically. In either case, the dye comprises a material that sublimes, usually by the application of heat. Thus positioning a suitably prepared transfer sheet against an article surface and applying heat will result in sublistatic printing of that article surface. During sublistatic printing, the heat forms microscopic tunnels or voids in the article surface, into which the dye vapour diffuses. When the heat is removed and the surface cools, the microscopic tunnels or voids contract and close so that the trapped dye can be observed through the semi-transparent surface material which makes the dye coloring as permanent as the object surface. Not all materials have surface properties suitable for sublistatic printing; those which do not (such as glass and ceramics) may be coated with a sublistatic dye-receptive material such as a polymer coating.

The coated articles with a sublistatic transfer sheet positioned against the surface, and with the elastic band encircling the articles, are conveyed through an oven 32. Oven 32 may be conventional or infrared. Sufficient heat is applied to initiate sublistatic printing onto costly material.

From oven 32, mugs are conveyed to an inspection area 34 where the elastic band is removed, the sublistatic transfer sheet is removed, and the final product is inspected for printing sharpness, registration and color. It has been found most effective to keep the temperature of the clear water and rinse solution within a range of 180 degrees Fahrenheit to 212 degrees Fahrenheit (82°C to100°C) for best results. It has also been found that drying and curing of bi-component, dye-receptive coating materials in a production environment requires

a minimum surface temperature of 365 degrees Fahrenheit (185°C) to achieve a satisfactory cure. Typical surface temperatures would be within the range of 365 degrees Fahrenheit to 410 degrees Fahrenheit (185°C to 210°C). It has also been found most effective to utilize temperatures of from 325 to 400 degrees Fahrenheit (163°C to 204°C) during the sublistatic printing of coated ceramic articles. Variations of these parameters occur due to the size of the ceramic being printed, the number of pieces being heated, and characteristics that are unique to different manufacturer's dyes and dye-receptive materials.

From the preceding description, it can be seen that a process for coating and sublistatically printing ceramic article surfaces has been provided that will meet all of the advantages of prior art processes and offer additional advantages not offered by such processes. Moreover, the use of a continuous conveyor system, and optionally, an infrared oven, expedites the process timing thereby resulting in greater volume and more efficient and less expensive procedures.

With respect to the foregoing description, the optimum dimensional relationship to the parts of the invention including variations in size, materials, shape, form, function, and manner of operation, use and assembly are deemed readily apparent to those skilled in the art and all equivalent relationships to those illustrated in the drawings and described in the specification are intended to be encompassed herein.

The foregoing is considered illustrative only of the principles of the invention. Since numerous modifications and changes will readily occur to those skilled in the art, it is intended not to limit the invention to the precise description and operation of the embodiment shown. All suitable modifications and equivalents that fall within the scope of the appended claims are deemed within the present inventive concept.

CLAIMS:

1. A process for sublistatically printing upon or decorating articles, comprising the steps of applying a dye-receptive coating to the articles, inspecting the coated articles for quality and consistency of coating thickness and subjecting the acceptable coatings on the articles to sublistatic printing; the articles being in substantially continuous motion between the coating application, inspection and printing steps.

2. A process as defined in claim 1, wherein the articles are prepared for application of the coating by washing and drying.

3. A process as defined claim 2, wherein the article preparation includes rinsing the articles in a solution containing clear water and a drying agent.

4. The process as claimed in claim 3 wherein the temperature of the rinse solution is within the range of 180 degrees Fahrenheit to 212 degrees Fahrenheit (82°C to 100°C).

5. A process as defined in any preceding claim, wherein the articles are positioned on selectively movable support devices.

6. The process as claimed in claim 5 wherein the support devices include one or more conveyors.

7. A process as defined in any preceding claim, wherein the articles are spray coated with a dye-receptive solution to form the coating thereon.

8. The process as claimed in claim 7 wherein the articles are introduced into a spray booth prior to the spraying operation.

9. A process as defined in any preceding claim, wherein the coated articles are moved through an oven to dry and cure the dye-receptive coating.

10. The process as claimed in claim 9 wherein the oven is an infrared oven.

11. The process as claimed in claim 9 or 10 wherein the surface temperature of the articles in the oven during drying and curing is within the range of 365 degrees Fahrenheit to 410 degrees Fahrenheit (185°C to 210°C).

12. A process as defined in any preceding claim, wherein the sublistatic printing step includes holding a transfer sheet on the articles by a mechanical device while applying heat to the articles.

13. A process as defined in any preceding claim, wherein the sublistatic printing step is carried out at a temperature in the range of 325 degrees Fahrenheit to 400 degrees Fahrenheit (163°C to 204°C).

14. A process as defined in any preceding claim, wherein the articles comprise glass or ceramics.

15. The process as claimed in any preceding claim, wherein the articles are mugs.

16. A process for coating and sublistatically printing the surfaces of ceramic or glass articles substantially as described with reference to or as shown in the drawings.

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1. A process for sublistatically printing upon or decorating articles, comprising the steps of applying a dye-receptive coating to the articles, inspecting the coated articles for quality and consistency of coating thickness and subjecting the acceptable coatings on the articles to sublistatic printing; the articles being in substantially continuous motion between the coating application, inspection and printing steps.

2. A process as defined in claim 1, wherein the articles are prepared for application of the coating by washing and drying.

3. A process as defined claim 2, wherein the article preparation includes rinsing the articles in a solution containing clear water and a drying agent.

4. The process as claimed in claim 3 wherein the temperature of the rinse solution is not less than 180 degrees Fahrenheit (82°C) and no greater than 212 degrees Fahrenheit (100°C).

5. A process as defined in any preceding claim, wherein the articles are positioned on selectively movable support devices.

6. The process as claimed in claim 5 wherein the support devices include one or more conveyors.

7. A process as defined in any preceding claim, wherein the articles are spray coated with a dye-receptive solution to form the coating thereon.

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12. A process as defined in any preceding claim, wherein the sublistatic printing step includes holding a transfer sheet on the articles by a mechanical device while applying heat to the articles.

13. A process as defined in any preceding claim, wherein the sublistatic printing step is carried out at a temperature not less than 325 degrees Fahrenheit (163°C) and no greater than 400 degrees Fahrenheit (204°C).

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The Patent Office

Application No:	GB 9815687.0	**Examiner:**	A J Rudge
Claims searched:	1-16	**Date of search:**	9 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B6C(CGAA)

Int Cl (Ed.6): B41F-17/00;17/28

Other: Online - WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	None	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.